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Indian Standard
SPECIFICATION FOR
QUADRATURE PHASE-SHIFTING
VOLTAGE TRANSFORMERS

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BUREAU OF INDIAN STANDARDS

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG

NEW DELHI 110002

Indian Standard

SPECIFICATION FOR QUADRATURE PHASE-SHIFTING VOLTAGE TRANSFORMERS

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SPECIFICATION FOR QUADRATURE PHASE-SHIFTING VOLTAGE TRANSFORMERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 22 May 1975, after the draft finalized by the Instrument Transformers Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers natural air-cooled quadrature phase-shifting voltage transformers to be used in conjunction with 3-phase kvarh meters used for measuring reactive energy.

1.2 This standard does not cover phase-shifting voltage transformers producing:

- a) a variable phase shift either continuously or in steps, and
- b) a phase shift other than 90° with respect to the input voltages.

2. TERMINOLOGY

2.0 For the purpose of this standard, following definitions, in addition to those given in IS : 1885 (Part XXVIII)-1972†, shall apply.

2.1 Quadrature Phase-Shifting Voltage Transformers — A voltage transformer used for producing a phase shift of 90° between the respective input and output voltage vectors.

*Rules for rounding off numerical values (revised).

†Electrotechnical vocabulary: Part XXVIII Instrument transformers.

2.2 Accuracy Class — A classification assigned to quadrature phase-shifting voltage transformers, the errors of which remain within specified limits under prescribed conditions of use.

3. CONSTRUCTION

3.1 A quadrature phase-shifting voltage transformer consists of two separate single-phase auto-wound transformers with suitable taps taken out and interconnected externally in such a way that output voltages are 90° out of phase with input voltages.

3.2 All the leads going to external circuits shall be brought to a suitable terminal plate.

4. RATINGS

4.1 Rated Voltage — The input voltage rating shall be 110 V when used in 110 V voltage transformer secondary circuits and 415 V when used directly in three-phase 415 V systems.

4.2 Output Voltage

4.2.1 In case of quadrature phase-shifting voltage transformers to be used along with three-phase, three-wire type kvarh meters, that is, three-phase, two-element type kvarh meters, the output shall consist of two separate voltages with a phase shift of 90° from two input line voltages. Magnitude of these voltages shall be equal to the input line voltages.

4.2.2 In case of quadrature phase-shifting voltage transformers to be used along with three-phase, four-wire type kvarh meters, that is, three-phase, three-element type kvarh meters, the output shall consist of three separate voltages with a phase shift of 90° from the three input phase voltages. Magnitude of these voltages shall be equal to the input phase voltages.

4.3 Rated Output — The quadrature phase-shifting voltage transformers shall be capable of supplying the burden of the voltage coils of kvarh meters without producing an error exceeding the limits specified in 8.

4.3.1 The preferred output ratings shall be 10, 25, 50 and 75 VA.

4.4 Rated Frequency — The rated frequency shall be 50 Hz.

5. INSULATION LEVELS

5.1 Test Voltage — The transformer shall be capable of withstanding a voltage of 2.5 kV (rms) at the rated frequency for one minute when applied between winding terminals and the casing, which may be earthed.

6. INSULATING MATERIALS

6.1 For these transformers Class A insulating materials specified in IS : 1271-1958* are recommended.

7. ACCURACY CLASS

7.1 Standard Accuracy Classes — The standard accuracy classes shall be 0.5, 1.0 and 3.0.

8. LIMITS OF VOLTAGE ERROR AND PHASE DISPLACEMENT

8.1 The voltage error and phase displacement at rated frequency shall not exceed the values given in Table 1 at any voltage between 80 percent and 120 percent of rated voltage and with burdens between 25 percent and 100 percent of rated output, at any power factor between unity and 0.8 lagging.

TABLE 1 LIMITS OF VOLTAGE ERROR AND PHASE DISPLACEMENT

CLASS	PERCENTAGE VOLTAGE (RATIO) ERROR	PHASE DISPLACEMENT
(1)	(2)	(3)
		Minutes
0.5	± 0.5	± 20
1.0	± 1.0	± 40
3.0	± 3.0	± 100

8.2 The error shall be determined at the terminals of the transformer and shall include the effects of any fuses or resistors supplied along with the transformer.

9. LIMITS OF TEMPERATURE-RISE

9.1 Temperature-rise of transformer windings above the ambient air temperature, when tested in accordance with 11.6, shall not exceed 55°C as measured by increase in resistance of winding.

NOTE — The reference ambient temperature for the purpose of temperature-rise measurement shall be 40°C.

10. MARKING

10.1 Rating Plate — All quadrature phase-shifting voltage transformers

*Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service.

shall have the following information marked on it or on a label permanently attached to it:

- a) Manufacturer's name and country of manufacture,
- b) Manufacturer's serial number,
- c) Rated voltage,
- d) Rated output in VA,
- e) Class of accuracy, and
- f) Circuit diagram and external connections.

10.2 Terminal Markings — All the terminals shall be clearly marked in accordance with Fig. 1.

NOTE — Vector diagrams of quadrature phase-shifting voltage transformers for use with both three-phase, three-wire and three-phase, four-wire energy meters to measure reactive energy have also been given in Fig. 2 for easy understanding.

10.3 Quadrature phase-shifting voltage transformers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

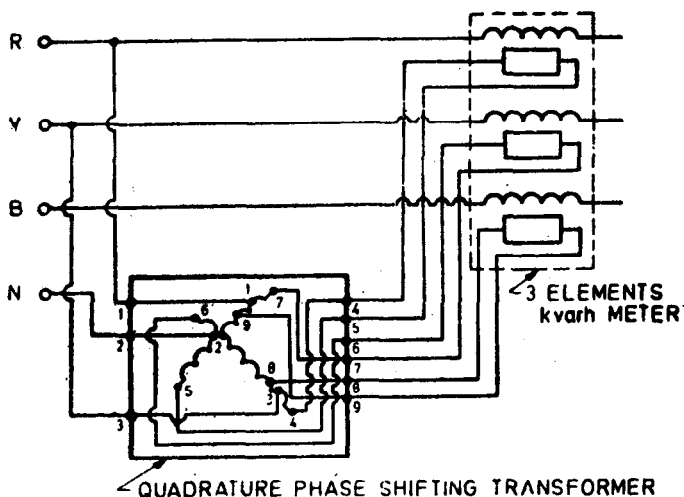
11. TESTS

11.0 Conditions for Tests— All testing shall be done at room temperature and with all external fittings in place which are likely to affect the performance, such as fuses.

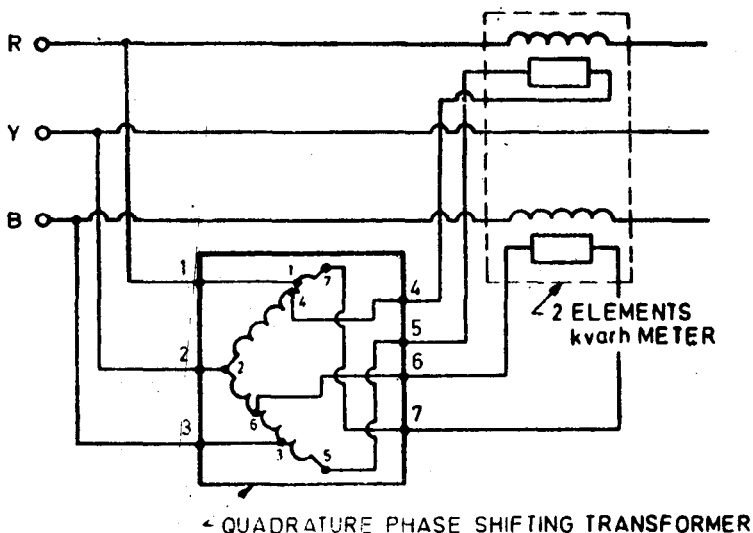
11.1 Classification of Tests

11.1.1 Following tests shall comprise the type tests:

- a) Verification of terminal markings and polarity (**11.2**),
- b) Accuracy test (type test) (**11.3**),
- c) Insulation resistance test (**11.4**),
- d) High voltage test (**11.5**),
- e) Temperature-rise test (**11.6**), and
- f) Induced voltage test (**11.7**).

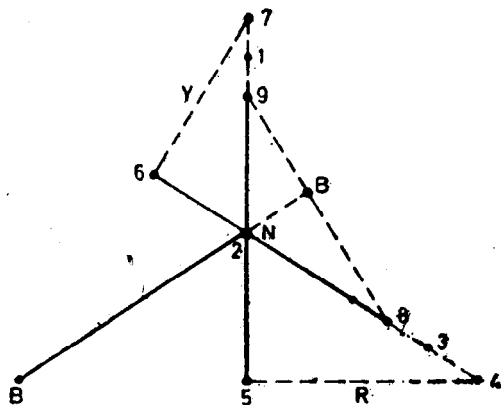


**1A Quadrature Phase-Shifting Voltage Transformer
for Use with Three-Phase, Four-Wire Meters**

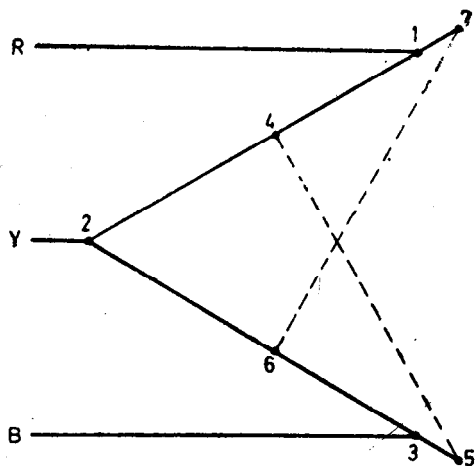


**1B Quadrature Phase-Shifting Voltage Transformer
for Use with Three-Phase, Three-Wire Meters**

**FIG. 1 TERMINAL MARKING FOR QUADRATURE PHASE-SHIFTING
VOLTAGE TRANSFORMERS**



2A Three-Phase, Four-Wire System



2B Three-Phase, Three-Wire System

FIG. 2 VECTOR DIAGRAM OF QUADRATURE PHASE-SHIFTING VOLTAGE TRANSFORMERS

11.1.2 Routine Test — Following tests shall comprise routine test and shall be carried out on all quadrature phase-shifting voltage transformers:

- a) Verification of terminal markings and polarity (11.2),
- b) Accuracy test (routine test) (11.8),
- c) Insulation resistance test (11.4),
- d) High voltage test (11.5), and
- e) Induced voltage test (11.7).

11.2 Verification of Terminal Markings and Polarity — Terminal markings and polarity shall be verified for their compliance with 10.2.

11.3 Accuracy Test (Type Test) — Quadrature phase-shifting voltage transformers shall be tested to comply with the requirements given in 8.1. The test shall be made at 80 percent, 100 percent and 120 percent of rated voltage at rated frequency and at 25 percent and 100 percent of rated burden. The power factor of the test burden shall be of any value between unity and 0.8 lagging. The test procedure shall be in accordance with 7.1 of IS : 3156 (Part II)-1965*.

11.4 Insulation Resistance Test — The insulation resistance between the terminals and the casing of the transformers shall be measured at 500 V dc. It shall not be less than 100 megohm when measured at ambient temperature not exceeding 40°C.

11.5 High Voltage Test — The transformer shall be subjected to a test voltage of 2.5 kV (rms) at rated frequency for one minute. The voltage shall be applied between winding terminals and the casing of the transformer, which shall be earthed. There shall be no disruptive discharge.

11.6 Temperature-Rise Test — The test may be made at any temperature not exceeding 40°C. For the purpose of this test rated burden shall be connected across the output terminals and rated voltages applied to the input terminals. Test voltage shall be applied till a steady temperature has been reached. It shall not exceed the value given in 9.1. The temperature-rise shall be measured by the increase in resistance method.

11.7 Induced Voltage Test — To test the inter-turn insulation of the winding, ac voltage shall be applied to each winding separately. The magnitude of the test voltage between any two terminals shall be twice the voltage appearing between those terminals when rated input voltage is applied to the input terminals. The test procedure shall be in accordance with 6.3 and 6.4 of IS : 3156 (Part I)-1965†.

11.8 Accuracy Test (Routine Test) — The quadrature phase-shifting voltage transformer shall comply with the requirements of 8.1. The test procedure shall be in accordance with 7.2 of IS : 3156 (Part II)-1965*.

*Specification for voltage transformers: Part II Measuring voltage transformers.

†Specification for voltage transformers: Part I General requirements.

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